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TRANSPORTATION
DEPARTMENT

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Traffic Signal Operations Design Guidelines

1. Objective:

The objective of this document is to provide traffic engineers a guide for the design of safe and efficient traffic signal phasing and timing plans in the City of Boston. The assumption has been made that the installation of any traffic signal under consideration has been justified based on the traffic signal warrant analysis procedure documented in the MUTCD and an engineering report clearly defining the need and purpose of the proposed signal. As in the development of any traffic-engineering plan, significant professional engineering judgment should be exercised.

2. Data Collection (minimum requirements)

a. A condition diagram depicting existing intersection layout including such features as roadway geometry, channelization, grades, number and width of travel lanes, lane use, speed limit, parking restrictions, driveways, bus stops and sight distance restrictions. The location of any adjacent schools, senior citizen facilities, parks, playgrounds, community centers, mass transit stations, hospitals and other significant pedestrian generating facilities should be noted on the diagram. The condition diagram should be developed as a result of a field evaluation.

b. Turning movement vehicle counts for each traffic movement from each approach and summarized in 15 - minute intervals. Coverage should be at least 7 AM to 6 PM on a weekday. Additional counts including nights and / or weekends may be required.

c. Pedestrian volume counts on each crosswalk during the same periods of the vehicular counts.

d. Existing phasing & timing data for signals on intersecting streets within 1,000 feet of subject location.

e. Most recent 3-year period of crash data available.

3. Traffic Operations Analysis

Perform intersection capacity analysis using collected data and BTD approved methodology to determine critical movements and establish a traffic signal phasing and timing plan. Proper analysis shall include AM peak and PM peak periods at a minimum. BTD may require timing plans for off-peak and / or weekend periods. If the signalized intersection is, or will be adjacent to or between existing traffic signals operating in a coordinated system, cycle lengths must be consistent with those used in the existing network to maintain proper coordination. Otherwise, all the signalized intersections operating in the coordinated system must be analyzed for new cycle, splits and offsets.

Traffic signal timing & phasing analysis shall be performed using an approved software package such as Synchro - Version 5.0 or higher. Other software packages may be acceptable with prior BTD approval. The traffic signal timing and phasing analysis must be calibrated to reflect current conditions. Both input and output files shall be submitted for review and approval by BTD. Printed, and/or electronic files may be required for submittal. Measures of Effectiveness (MOEs) such as Average Delay, Level of Service (LOS), Volume to Capacity Ratio (V/C) and 95% Vehicle Queues for each scenario, including the existing condition, shall be summarized on a table by movement, approach and intersection total for each scenario analyzed. Additional MOEs and / or system-wide MOEs may need to be summarized as required by BTD.

It is known that the goals of traffic safety and traffic capacity may conflict when determining the number of phases for an intersection. In all cases, the treatment of left-turn movements and pedestrian flows must be considered in the phasing and timing plan development. In order to maximize efficiency of signalized intersections, BTD requires that traffic signal controllers be designed for the minimum number of phases that are necessary to provide an acceptable level of safety. With this in mind, the traffic engineer must carefully select the appropriate use of protected / exclusive controller phases. Intersections that experience heavy conflicts between turning vehicles and pedestrians and / or between turning vehicles and through traffic or have restricted sight distance may require a protected / exclusive phase, which will have a detrimental effect on intersection operation and capacity.

4. Operational Considerations

a. Signal cycle lengths should be designed to reduce delays to both vehicles and pedestrians while maintaining adequate LOS and traffic signal coordination.

b. The signal phasing and timing plans should be designed for a vehicular LOS "D" or better where attainable and a V/C ratio of 0.85 or lower for each approach during peak hours.

c. Pedestrian WALK intervals should be maximized in correlation with corresponding vehicular movements.

d. A Pedestrian WALK interval shall be provided concurrently with the vehicular GREEN interval for the non-conflicting crosswalks at intersections with one-way streets.

e. Flashing DON'T WALK time shall be calculated as per the MUTCD (Manual on Uniform Traffic Control Devices).

f. Historically, exclusive pedestrian phases have been routinely incorporated into traffic signalization plans in Boston. The Boston Transportation Department encourages the use of concurrent pedestrian phases where appropriate, to ensure more pedestrians cross with the WALK phase and to reduce delays to pedestrians and vehicles.

Concurrent WALK should be considered where the following criteria are met:

- Where concurrent WALK phasing will improve operations (i.e. reduce delays to both vehicles and pedestrians)
- At intersections where conflicting turning volumes are low (typically less than 250 vph) and
- Where sight distance is not restricted.
- Leading pedestrian intervals may be considered where appropriate.

g. *Exclusive* WALK should be considered in the following cases:

- At intersections where conflicting turning volumes are high (greater than or equal to 250 vph) and pedestrian volumes are high.
- Sight distance is restricted to less than 250 feet when speeds are 35 mph or less. Sight distance is restricted to less than 400 feet when speeds are 40 mph or higher.
- Intersection geometry dictates that concurrent pedestrian crossings may be confusing or dangerous.
- At intersections within "safety zones" near elderly housing, schools, recreational areas, playgrounds, and health facilities, etc...

h. Protected or Protected / Permissive left-turn phase should be considered in the following cases:

- The cross-product of the left-turn traffic multiplied by the opposing traffic is greater than 100,000 for 2 or more lanes and the left-turn volumes are at least 75 vph, during the two peak hours.
- Sight distance is restricted to less than 250 feet when speeds are 35 mph or less. Sight distance is restricted to less than 400 feet when speeds are 40 mph or higher.
- There were 4 or more left-turn crashes in the last year or 6 in the last 2 years that are susceptible to correction.
- There is more than one left-turn lane.
- Intersection geometry dictates that permissive left-turns may be confusing or dangerous (i.e.; 5-legged or skewed intersections).
- Turn arrows should only be used to indicate protected turn phases.

i. Pedestrian intervals should be designed so that pedestrians can cross the entire street on one phase. If a multi-phase pedestrian walk is the most feasible alternative, a pedestrian push-button must be installed. The median width shall not be less than 6 feet.

j. New traffic signal equipment shall be designed to meet BTD signal system specifications and allow for maximum flexibility such as providing automatic pedestrian phasing during certain times of the day and providing pedestrian and / or vehicle overlap phases that allow pedestrians and / or vehicles to move during multiple phases when appropriate.

Approved:

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